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SPREAD OF PLAGUE IN THE SOUTHERN AND 25X1A9a
CENTRAL DIVISIONS OF BOMBAY PROVINCE
AND
PLAGUE ENDEMIC CENTRES IN THE
INDO-PAKISTAN SUBCONTINENT ^a

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The findings of the Plague Recrudescence Inquiry in Sholapur and Adjoining Districts, conducted by Sharif & Narasimham ^{11, 12} in the districts of Sholapur and Dharwar during 1940 to 1943, do not support the idea that wild rodents help to carry plague infection from one place to another as in "temperate climes".⁴ Wild rodents cannot be considered responsible for plague in Bombay Province, though they have been shown to be so in Transbaikalia, Mongolia, South-Eastern Russia, South Africa, and the western parts of the USA.¹⁷ In Bombay Province, the domestic rat perpetuates the plague infection. In some suitable places the infection among domestic rats goes on throughout the year. The infection is not apparent during the hot and dry season, its intensity being diminished because of the ill effect of prevailing climatic conditions on the wanderings of adult rat-fleas; it pursues the course of a slow subterranean enzootic from burrow to burrow. The conclusion of the off-season^c is characterized by the advent of the rainy season, which exerts its influence in two ways: first, it causes the rats from outside shelters to herd into burrows indoors and remain there perforce, which results in a considerable increase in the rat population within houses; secondly, it brings down the temperature and increases the humidity to such an extent as to result in a striking rise in the flea population and to allow rat-fleas to come out of burrows to attack human beings. The stage is thus set for the infection in rats to flare up again and cause human plague.

Both the survey and the study of dispersal of plague during the period of 1930 to 1945 in the different districts of the southern and central divisions

^a Communicated by Major-General Sir Sahib Singh Sokhey to the first session of the Expert Committee on Plague of the World Health Organization, Geneva, September 1949. The present version contains several amendments.

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^c "Plague season", as used in this paper, comprises the months in which human plague incidence is high, and "off-season" denotes the months in which either there is no incidence of human plague or in which it is very low as compared with that in the plague season.

have confirmed the previous assumption that the commercial towns, dealing with agricultural products such as grains, raw cotton, cotton seed, etc., are the chief distributing foci of plague through the passive transference mostly of rat-fleas and partly of rats in the rat-favoured merchandise^{1, 2} carried in railway trucks, motor lorries, bullock-carts, etc.^d It has been observed that, though this disease may not break out, at present, to a great extent in the large grain-distributing centres themselves, the latter still play an important part in the spread of plague to villages. Owing to very large numbers of domestic rats in these commercial towns being immune as the result of severe infections to which they have been exposed from time to time during the past severe epizootics, the imported infection only smoulders among the few susceptible rats as long as possible, without leading to severe human outbreaks. On the contrary, however, if the infection is introduced from these trading centres into the comparatively more susceptible rat-populations of villages, it flares up into severe epizootics, leading to many human cases. Thus the difference in the susceptibility of the rats in different places seems to play an important role in the dissemination and recrudescence of plague, as has been pointed out by Sokhey.^{13, 14}

The study of the state of infection in the parts of Bombay Province surveyed has led me to the conclusion that there are two distinct types of plague epizootics, as has been mentioned by previous workers.^{2, 15} In most of the localities in the comparatively warm, almost treeless, low tablelands and plains, the infection, like a conflagration, is short-lived : it flares up intensively, resulting in explosive epizootics among rats, and then is more or less extinguished within a few months of the rainy and the winter seasons. This is perhaps due to a greater multiplication of the rat-fleas and of the plague organisms in them on account of the optimum prevailing climatic conditions. During the hot and dry months of summer, however, the infection often disappears from many villages, so much so that reappearance of plague in them is more or less the result of fresh importation from commercial centres. The latter seem to be capable of retaining the subdued infection for a longer time than the villages, on account of a larger population of domestic rats and the comparatively more favourable micro-climatic conditions of the rat burrows in the grain godowns and other premises well protected against sun. Such favourable conditions are less likely, especially in small villages, where hot and dry climatic conditions exercise a great check on the activities of rat-fleas. On the other hand, in places located in the much cooler, hilly, and wooded tracts found on the eastern gradual slopes of the Western Ghats, locally known as *malad* area,¹⁵ especially in the districts of Dharwar, Belgaum, Satara, and Poona, the

^d Rat-fleas are also carried on human beings in their personal effects,³ especially on those not accustomed to the frequent use of soap. The transport of rat-fleas by this means has been observed in many instances. Usually, however, plague is spread in this way for short distances only, because the rat-fleas leave man, who is not their permanent host, after a short time.

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infection is slow-spreading and lasts much longer, like a smouldering fire, on account of the retarding effect of the comparatively low prevailing temperature in the winter and the rainy seasons on the increase of fleas and of plague bacilli in them. Consequently, the infection does not lead to a very high and quick rate of mortality among their rodents. The reoccurrence of plague in towns, and even in some villages, of these areas is the result of carrying-over. Kunhardt & Chitre⁸ and Strickland¹⁵ also observed that cooler places have better capacity for carrying over plague than have warmer ones. The climatic conditions of these cooler regions approximate to what they would be in endemic centres, as the factors here are very favourable for the lingering-on and carrying-over of plague infection from one season to another ; consequently, they have been termed endemic areas.

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1. A Method of Studying Spread of Plague

In order to study properly the progress of a migratory disease like plague, as is required for the forecast of its epidemics, plotting of infected places on skeleton maps is essential. In the case of plague, where rodents play the chief part, plotting of localities having epizootics would have been ideal ; but, owing to non-availability of such information, the analysis of past epidemics must suffice and should throw some light on the factors responsible for the dispersal of plague and its progress. For this purpose, plague-infected places of the districts in the central and southern divisions of Bombay Province (information supplied by the Director of Public Health of the province) were plotted on skeleton district maps with the help of topographical taluka maps (printed by the Government Photo Zinco Office, Poona), on which the position of almost every place is given. Unfortunately, it was not possible to plot the plague-infected localities of intervening small States, as neither skeleton nor topographical maps of them were available ; but their absence will not materially affect the study of the progress of plague in these divisions of Bombay Province.

In plotting, each plague-infected place is denoted by a small circle, the circumference of which is divided into twelve equal parts, as for hour-figures on a watch dial, to represent the months of the calendar year. The sector between XII and I hour-figures indicates the month of January, that between I and II hour-figures the month of February, and so forth. The duration of plague in a place is shown in the map by shading the sectors representing the infected months. On each district skeleton map, plague records were plotted for two years, and in a few cases even for three years, to economize in the use of such maps. In the original spot maps, the infected localities of the first year were denoted by black circles, those of the second year by red circles, and of the third year by blue circles. Whenever a place evinced infection in the same calendar months of two years, a red arc was added to the outside of the black circle connecting the

first and the last months of plague infection of the second year. In the accompanying maps, black and red circles have been replaced by continuous line and dotted circles and blue ones by double line circles. The plotting of infected localities is fairly accurate, as their exact position was determined with the help of two set-squares on both the skeleton and the topographical maps.

Spot maps of Dharwar and Bijapur districts and of other districts of the central and the southern divisions of Bombay Province for the period of 1930 to 1945, and lists of their plague-infected localities, arranged taluka-wise, are kept at the Haffkine Institute, Parel, Bombay.

Spot maps of the district of Dharwar, containing the endemic plague area, for the years 1935 to 1940, and of the Bijapur District, having no such endemic area, for 1935 to 1943, along with the lists of their plague-infected places, are given in this paper for the purpose of illustration (fig. 1-6, annexes 1 and 2).

The technique adopted for recording plague-infected places has yielded fairly interesting results. It is hoped that similar studies will be undertaken in other regions so as to increase the knowledge of the dissemination of plague. It is suggested, however, that it would help a good deal if the plague year, from the first month of the plague season to the last month of the off-season, were utilized, instead of the calendar year, for plotting maps. This would obviate many difficulties which I had to face in assessing the data. Originally it was intended to do so; but, unfortunately, owing to circumstances over which I had no control, it could not be managed.

2. Dispersal of Plague in Two Divisions of Bombay Province

To study the spread of plague, it was necessary to trace the progress of the disease in different districts and to correlate the course of plague incidence in the adjoining districts as well. For this purpose, the duration of human-plague incidence and the commencement of the disease in the neighbouring places were taken into consideration, and localities showing infection throughout the year were given special attention.

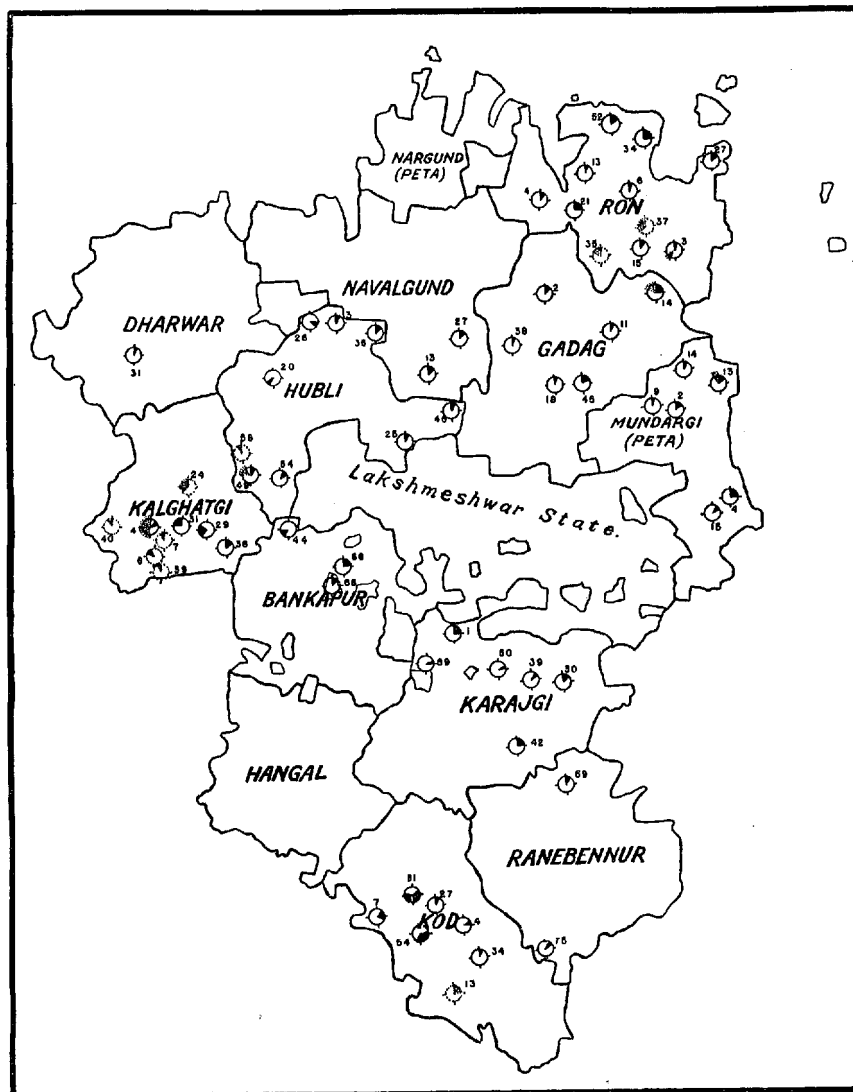
As all the maps could not be reproduced here, a brief account of the course of human-plague incidence in each district from year to year is considered necessary.

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FIG. 1. PLAGUE-INFECTED LOCALITIES IN THE DHARWAR DISTRICT
1935-1936



1935 — continuous line circles with dark sectors

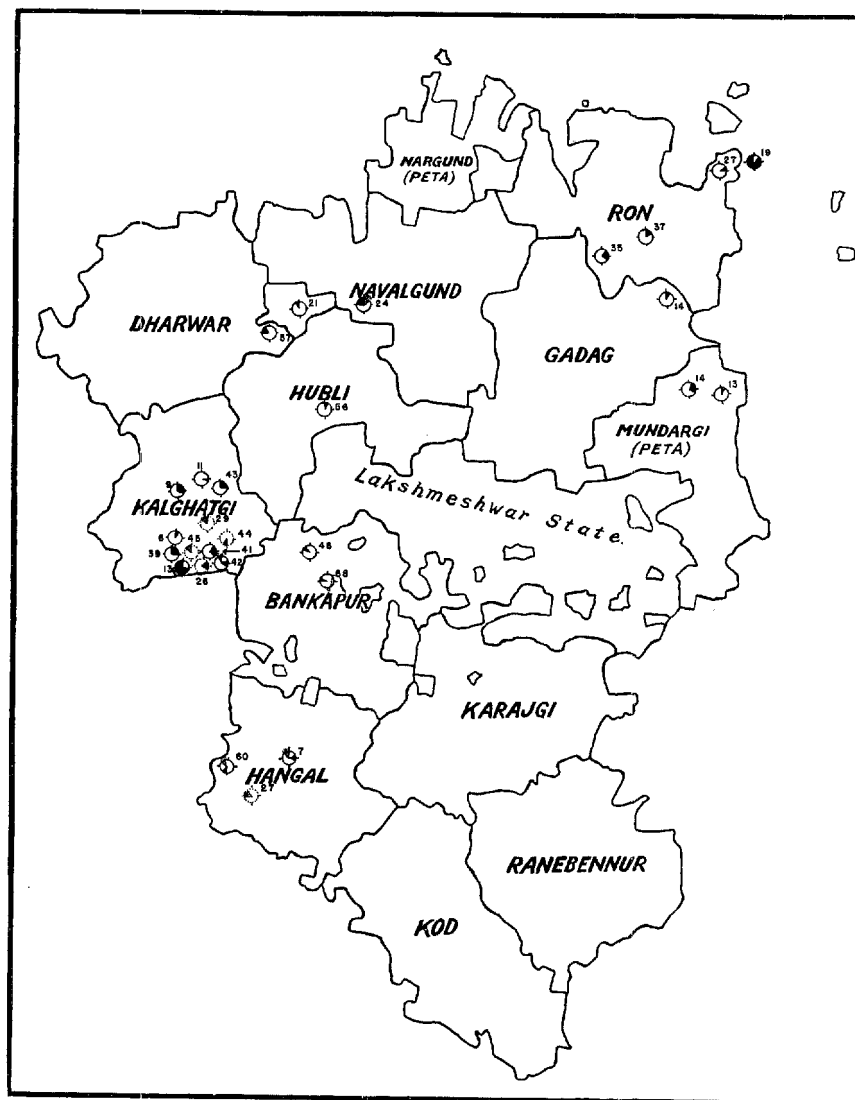
1936 — dotted line circles or continuous line circles with
dotted sectors and dotted arcs

The numbers near the circles correspond to the serial numbers of the infected places listed
according to taluka (see annex 1, page 101).

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FIG. 2. PLAGUE-INFECTED LOCALITIES IN THE DHARWAR DISTRICT
1937-1938



1937 — continuous line circles with dark sectors

1938 — dotted line circles or continuous line circles with
dotted sectors and dotted arcs

The numbers near the circles correspond to the serial numbers of the infected places listed
according to taluka (see annex 1, page 101).

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2.1 *Dharwar District*

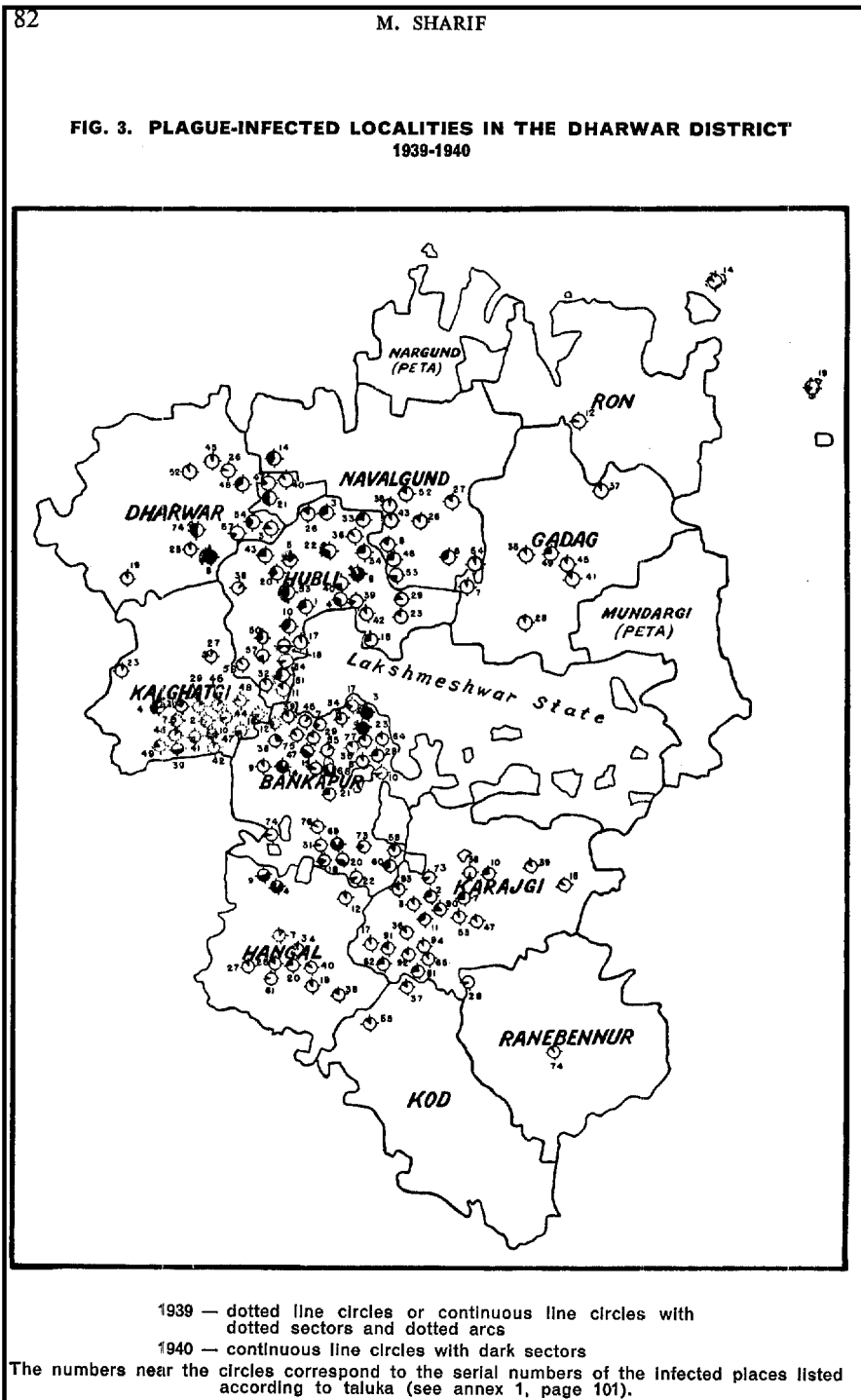
The incidence of human plague in the Dharwar District may thus be summarized :

Year	<i>Localities affected</i>			<i>Description of outbreaks</i>
	<i>Total number</i>	<i>In endemic area</i>	<i>In non-endemic area</i>	
1930	174	77	97	Plague widely dispersed throughout the district and 77 places affected in the watershed ^e areas belonged to the talukas of Dharwar, Kalghatgi, Bankapur, Hangal, and Kod, which form the endemic area.
1931	92	57	35	Infection showed, in general, a downward trend, and was mainly confined to the endemic zone, where 3 places remained affected throughout the year, but never persisted so long in any locality in the non-endemic talukas.
1932	166	105	61	The disease showed an eastward progression, though the endemic western talukas were more seriously involved.
1933	283	111	172	The infection having penetrated into the eastern parts, practically the whole of the district was involved.
1934	285	78	207	Recrudescence followed by a further extension of the infected area.
1935	53	14	39	Reduction in the number of infected localities which, however, were still scattered all over the district (see fig. 1 and annex 1).
1936	14	7	7	Downward trend continued.
1937	23	14	9	In addition to talukas within the watershed areas, plague was present in the non-endemic talukas of Ron, Gadag, Hubli, and Navalgund (see fig. 2 and annex 1).
1938	10	9	1	Plague practically restricted to its natural haunts.
1939	37	27	10	The infection again showed a tendency to spread eastwards (see fig. 3 and annex 1).
1940	138	64	74	Spread eastwards more marked.
1941	273	101	172	Plague active all over the district.
1942	56	22	34	Marked downward trend.
1943	3	2	1	2 of these foci were located in the taluka of Dharwar, 1 in that of Ranebennur.
1944	4	2	2	Involved were 3 villages in Dharwar and Hubli talukas, in addition to an isolated village in the Ron Taluka.
1945	9	9	0	Plague present in only 9 localities of Dharwar, Kod, and Hangal talukas having the watershed areas.

Sixteen years' plague records clearly show that the infection has never left the watersheds of the Dharwar District, from where it radiated mostly eastwards. Plague was largely confined to the western endemic talukas in 1931 and started spreading eastwards with greater intensity in the following year. The epidemics gathered momentum in 1933 and 1934. Following

^e The term "watershed" is used in this paper in the sense of the gathering ground of a river or rivulet, which includes the gradual slopes of hilly regions forming broad valleys.

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a downward trend during 1935, the incidence of the disease was considerably reduced in 1936, when it was largely restricted to the western endemic zone. After remaining entrenched there for another two years (1937 and 1938), the infection started inundating the eastern non-endemic talukas during 1939 and 1940 and reached a peak in 1941. A decline started again during 1942, and there was only a slight recrudescence in the western endemic area during the period 1943-1945, with practically no spread eastwards. Thus the initial five years' cycle with three years' wide dispersal was increased to seven years, the infection remaining for two additional years in the endemic area.

2.2 Belgaum District

The trend of plague infection in this district during the period 1932-1945 is given below :

Year	Localities affected			Description of outbreaks
	Total number	In endemic area	In non-endemic area	
1932	223	101	122	Plague active all over the district. 101 of the foci located in the talukas of Khanapur, Belgaum, Chandgad, Hukeri, and Chikodi, having the watersheds of the Western Ghats and constituting the endemic zone of the district.
1933	306	131	175	Considerable spread of the infection.
1934	179	86	93	Infection scattered all over the district.
1935	22	10	12	Affected localities belonged to many widely separated talukas.
1936	9	9	0	Infection restricted to watershed areas.
1937	34	32	2	Infection mostly confined to the western endemic area.
1938	25	23	2	
1939	29	19	10	Plague started to spread, especially to the south-east.
1940	76	28	48	Further spread eastwards.
1941	72	32	40	Situation remained stationary (no further spread).
1942	22	6	16	Decline starting.
1943	19	15	4	Infection mostly confined to its permanent haunts.
1944	36	29	7	
1945	120	98	22	Plague still most prevalent in the watershed areas, yet slight spread eastwards started.

The observations made in the Belgaum District are analogous to those in the Dharwar District, plague persisting in the watershed regions and spreading eastwards from there. The records for both districts show that this eastward progress depends upon the intensity of the infection. In 1940 and 1941, plague was more intense in the Dharwar District than in the

^f The records for 1930 and 1931 were not made available to me.

Belgaum District. Consequently, the disease extended to the far eastern end of the former district, while in the latter district this was not so, and the dispersal was not wide. Analysing the outbreaks in these two districts during the seven years' period of 1914-1920, Strickland¹⁵ suggested "a distinct difference in plague-incidence between the eastern dry zone (or cotton *desh*) and the more humid western *malad* (paddy-growing zone)", which is also borne out by my findings.

2.3 Satara District

Figures showing the plague incidence in the Satara District during the period under review are as follows :

Year	Localities affected			Description of outbreaks
	Total number	In endemic area	In non-endemic area	
1930	53	29	24	Plague widely spread ; 29 places in the watersheds.
1931	28	23	5	Infection mainly restricted to the watershed areas.
1932	131	73	58	Spread eastwards starting. 73 of the infected places were located in the talukas of Wai, Javali, Satara, Patan, Karad, Shirala, and Valva which, having the watersheds of the Western Ghats, form the endemic area of the district.
1933	142	63	79	Infection remained widespread.
1934	140	64	76	
1935	81	45	36	Downward trend starting.
1936	14	14	0	Slight plague incidence, restricted to the endemic area.
1937	7	7	0	
1938	5	5	0	
1939	2	2	0	
1940-				
1942	0	0	0	No plague.
1943	3	2	1	2 of the infected places were situated in the Javali Taluka having watersheds.
1944	98	38	60	Marked recrudescence with considerable spread eastwards.
1945	339	190	149	Plague very active.

The course of plague incidence in the district of Satara during the 16 years 1930-1945 has shown the same trend as in the Belgaum District ; but, owing to a very low intensity of the infection during the period 1936-1939, the former district was free from plague from 1940 to 1942. The greater intensity of the infection in 1944 was, however, responsible for a flare-up throughout the district during 1945.

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2.4 Poona District

The plague records for the period 1930-1945 may thus be summarized :

Year	Localities affected			Description of outbreaks
	Total number	In endemic area	In non-endemic area	
1930	10	1	9	Slight plague incidence throughout the district; only in Poona City in the endemic zone.
1931	0	0	0	No plague.
1932	1	1	0	Plague present in Poona City only, having presumably been imported from the Satara District.
1933	107	77	30	77 of the foci were situated in the talukas of Junnar, Ambegaon, Khed, Maval, Haveli, Poona, and Mulshi containing the watershed areas of the Western Ghats, which constitute the endemic area of the district.
1934	84	51	33	Plague continued to occur throughout the district.
1935	2	1	1	Most marked decline in 1935, leading to a total disappearance of plague during 1936 and 1937.
1936	0	0	0	
1937	0	0	0	
1938	1	1	0	Outbreak in Poona City only.
1939	1	1	0	Only 1 place in the Haveli Taluka affected.
1940	2	1	1	Poona City was again infected.
1941	5	4	1	Plague reappeared in Poona City.
1942	11	11	0	The infection having gained some momentum in the Maval Taluka, 11 places within it were affected.
1943	54	49	5	Some spread of the infection eastwards took place.
1944	86	73	13	Further eastward progress of plague.
1945	173	91	82	The infection continued to spread eastwards, reaching the easternmost talukas of the district.

Sixteen years' plague records of the Poona District also demonstrate the eastward progression of the disease from the talukas containing watersheds of the Western Ghats. The course of events was similar to that in the Satara District. The very low intensity of the infection in the Poona District in 1930 and again in 1935 resulted in the complete absence of the disease during the succeeding years of 1931, and of 1936 to 1937, respectively. The intensity of plague was very slight during the period of 1938 to 1940, so that the infection could not gain any momentum : in 1941 and 1942, however, plague gathered enough momentum to spread eastwards ; consequently, a large number of places were affected during the period 1943 to 1945. Poona City appears to have been twice responsible for a wide dispersal of plague so that suitable and adequate antiplague measures in this city alone would have saved the whole district. However, the infection remained, on the whole, restricted to the endemic talukas, and the eastward dispersion was insignificant.

2.5 *Nasik District*

While the district at large remained free from plague during the period 1930 to 1936, Nasik City was infected in 1930, 1932, and 1936. Only one place in the Baglan Taluka was affected in 1937, and the whole district remained free from plague during the period of 1938 to 1944. In 1945, however, the disease was reported from 64 localities scattered all over the district, 30 of the foci being situated in the taluka of Nasik. If the periods during which the various places became affected are arranged in chronological order, there appears to be a definite shift of the infection eastwards and north-eastwards from the Nasik Taluka; thus in this district also plague radiates from the watersheds to the flat, warm, eastern areas.

2.6 *East- and West-Khandesh Districts*

East Khandesh, which was free from plague during the period of 1930 to 1944, became infected in 1945, from the Nasik District, when 15 places belonging to the taluka of Chalisgaon and one to that of Pachora were affected. In the West-Khandesh District, only the Dhulia Town received infection during 1933 from the Nasik District, where plague had been present in December 1932. The Dhulia Town was again invaded from the Nasik District during 1945 and continued to show infection in 1946, when Sakri in West Khandesh was also involved.

2.7 *North Kanara District*

The plague history of the North Kanara District may thus be summarized :

<i>Year</i>	<i>Localities affected</i>	<i>Description of outbreaks</i>
1930	14	8 of the infected localities were in the taluka of Haliyal and the Mundgod Peta, bordering on the Dharwar District which, as noted above (see page 81), was heavily infected at the time. Plague was also present in the taluka towns of Yellapur, Sirsi, Ankola, and Karwar as well as in 2 villages near Karwar Town.
1931	24	14 of the affected places belonged to the Haliyal Taluka and the Mundgod Peta, 4 to the Karwar Taluka, where besides the taluka town 3 adjoining villages were involved. The other infected places included the towns of Sirsi and Kumta, Yellapur Town with a neighbouring village, and 2 localities in the Supa Peta.
1932	35	24 of the foci were situated in the Haliyal Taluka and the Mundgod Peta, 8 in the Karwar Taluka, and 1 in the Supa Peta. The taluka towns of Ankola and Sirsi had plague as well.
1933	29	Involved were 23 localities of the Haliyal Taluka and the Mundgod Peta, 3 of the Karwar Taluka (the taluka town and 2 neighbouring villages), 2 in the Supa Peta and the Sirsi Town.
1934	33	Epidemics occurred in 33 well-separated localities of the Haliyal, Yellapur, Sirsi, Kumta, Ankola, and Karwar talukas.
1935	9	Outbreaks were reported from the Karwar Town and 2 adjacent villages, the Sirsi Town with 1 adjoining village, the Kumta Town, and 1 locality in each of the talukas of Haliyal, Honavar, and Ankola.

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<i>Year</i>	<i>Localities affected</i>	<i>Description of outbreaks</i>
1936	3	Since, as described above (see page 81), there was a little plague in the neighbouring parts of the Dharwar District, the Haliyal Taluka and the Mundgod Peta did not experience plague, which was present in the taluka towns of Karwar, Ankola, and Sirsi only.
1937	9	5 of the affected localities belonged to the taluka of Haliyal and the Mundgod Peta. Plague was also present in the towns of Sirsi and Kumta, near each of which 1 village was involved.
1938	8	Besides 5 places situated in the Haliyal Taluka and the Mungdod Peta, the towns of Karwar and Sirsi as well as 1 village near the latter were involved.
1939	10	The affected localities included Sirsi and Ankola Towns, 3 places in the Mundgod Peta, and 5 in the Karwar Taluka.
1940	13	Plague was recorded from 4 places in each of the talukas of Siddapur and Karwar, from Sirsi Town and 1 neighbouring village, and from 3 localities in the Mundgod Peta and the taluka of Haliyal.
1941	19	10 of the foci were in the Haliyal Taluka and the Mundgod Peta, 4 in the taluka of Sirsi, and 3 in that of Karwar. The towns of Honavar and Bhatkal were also infected.
1942	8	Affected were the Sirsi Town, 4 places in the Bhatkal Peta, 2 in the taluka of Haliyal, and 1 in that of Siddapur.
1943	8	Besides the Bhatkal Town, plague was present in 2 localities of the taluka of Haliyal, 3 in that of Sirsi, and 2 in that of Siddapur.
1944	6	Involved were 3 places in the taluka of Haliyal and the Mundgod Peta, 1 in the Kumta Taluka, and Sirsi and Bhatkal Towns.
1945	1	Only 1 locality belonging to the Siddapur Taluka was affected.

Plague records of this district for 16 years reveal that the outbreaks have always been sporadic. Owing to their proximity to the endemic area of the Dharwar District, places in the taluka of Haliyal and the Mundgod Peta were particularly affected. Generally speaking, the North Kanara District, comprising mainly the western, well drained, steep slopes of the Western Ghats, which contain forest-clad hills with deep valleys, and the uplands of the ghats, has suffered very little from plague. Only a few commercial towns trading with the endemic areas in Dharwar and Belgaum districts have often manifested the disease, which never showed a tendency to spread widely. Sirsi Town suffered from plague almost every year, and the same held true of the towns of Haliyal, Mundgod, and Karwar.

2.8 Ratnagiri District

The following plague outbreaks were recorded from the Ratnagiri District :

<i>Year</i>	<i>Localities affected</i>	<i>Description of outbreaks</i>
1930	15	9 of the places involved (7 in the taluka of Chiplun and 2 in that of Dapoli) were infected from the Satara District, 4 in the Vengurla Taluka from the Belgaum District. 2 places in the Sangameshwar Taluka might have received infection from the Kolhapur State.

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<i>Year</i>	<i>Localities affected</i>	<i>Description of outbreaks</i>
1931	1	Vengurla Town alone was affected.
1932	2	Besides the town of Vengurla, the Ratnagiri Town also had plague.
1933	4	Infected were the town of Malwan, the Vengurla Town, and a neighbouring village in the taluka of Dabholi, as well as Ghogare in the Khed Taluka.
1934	13	8 of the foci were in the neighbourhood of Ratnagiri Town, 4 in the talukas of Vengurla and Malwan, and 1 in the Khed Taluka.
1935	4	Besides 3 places in the Vengurla Taluka, 1 near the town of Ratnagiri was affected.
1936-1938	1	1936 and 1937 were plague-free years. In 1938, plague was present only in the town of Vengurla.
1939-1944	3	The whole district was free from plague during the periods of 1939-1940 and 1942-1944, but in 1941, 3 places in the taluka of Ratnagiri, including Ratnagiri Town, were affected.
1945	12	Involved were the taluka towns of Ratnagiri, Chiplun (with an adjoining village), Rajapur, Khed (with a nearby village in the Dapoli Taluka), Kankavli, and Guhagar with 2 villages in the neighbourhood as well as 2 places in the taluka of Sangameshwar.

A consideration of these records leads to the conclusion that the disease did not spread all over the district of Ratnagiri ; only the commercial towns derived infection from the districts of Satara and Belgaum, possibly also from the Kolhapur State, and occasional spread to neighbouring localities took place. However, sometimes places on the roads leading to the trading centres became involved.

2.9 Kolaba District

Plague was completely absent from this district during the period of 1930 to 1941. Due possibly to an importation of the infection from the district of Poona, a small village of the Karjat Taluka became affected in 1942. There was no plague in the district of Kolaba during 1943, but the presence of the disease was recorded in five places of the Karjat Taluka in 1944. During 1945, outbreaks occurred in 11 localities ; five of them were in the Mahad Taluka, being the taluka town and adjoining villages; the others were a small village on a motor road leading to the taluka town of Mangaon, the Pen Town, and the towns of Panwal and Alibag, the infection spreading from each of the two last-mentioned places to a neighbouring village.

This district, comprising largely the western slopes and uplands of the Western Ghats, has suffered very little from plague, the infection imported into the trading centres showing rather slight tendency to spread.

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2.10 *Sholapur District*

The plague records for the district of Sholapur may thus be summarized :

<i>Year</i>	<i>Localities affected</i>	<i>Description of outbreaks</i>
1930	24	16 of the infected places belonged to the Barsi Taluka which is surrounded by the Hyderabad State, while 5 of the other localities were either close to the Hyderabad State or near the Barsi Light Railway Line.
1931	0	No plague in the whole district.
1932	14	11 of the involved localities were in the taluka of Barsi.
1933	76	55 of the foci were situated in the talukas of Barsi and Sholapur adjoining the Hyderabad State, while many of the rest were not far from the Barsi Light Railway Line.
1934	83	The distribution of the plague foci was similar to that in 1933 ; 58 of them were situated in the Barsi and Sholapur talukas.
1935	19	All but 1 of the foci were located in the 2 above-mentioned talukas.
1936-1938	4	Plague, which involved only 4 villages in these 2 talukas during 1936, was altogether absent during the 2 following years.
1939	49	Only places in the talukas of Barsi and Sholapur became infected.
1940	58	Plague remained practically restricted to these 2 talukas, where 57 of the affected localities were situated.
1941-1942	7	The infection, present in 7 places of the Barsi and Sholapur talukas during 1941, was altogether absent from the district in 1942.
1943	9	4 of the infected places were situated in the talukas of Barsi and Sholapur.
1944	75	Outbreaks were noted in 50 places of the 2 last-mentioned talukas and in 14 of the Madha Taluka.
1945	143	The infection remained most prevalent in the talukas of Barsi and Sholapur (85 localities affected). 14 places were involved in the talukas of Madha and Karmala which, like the 2 talukas mentioned before, border on the Hyderabad State.

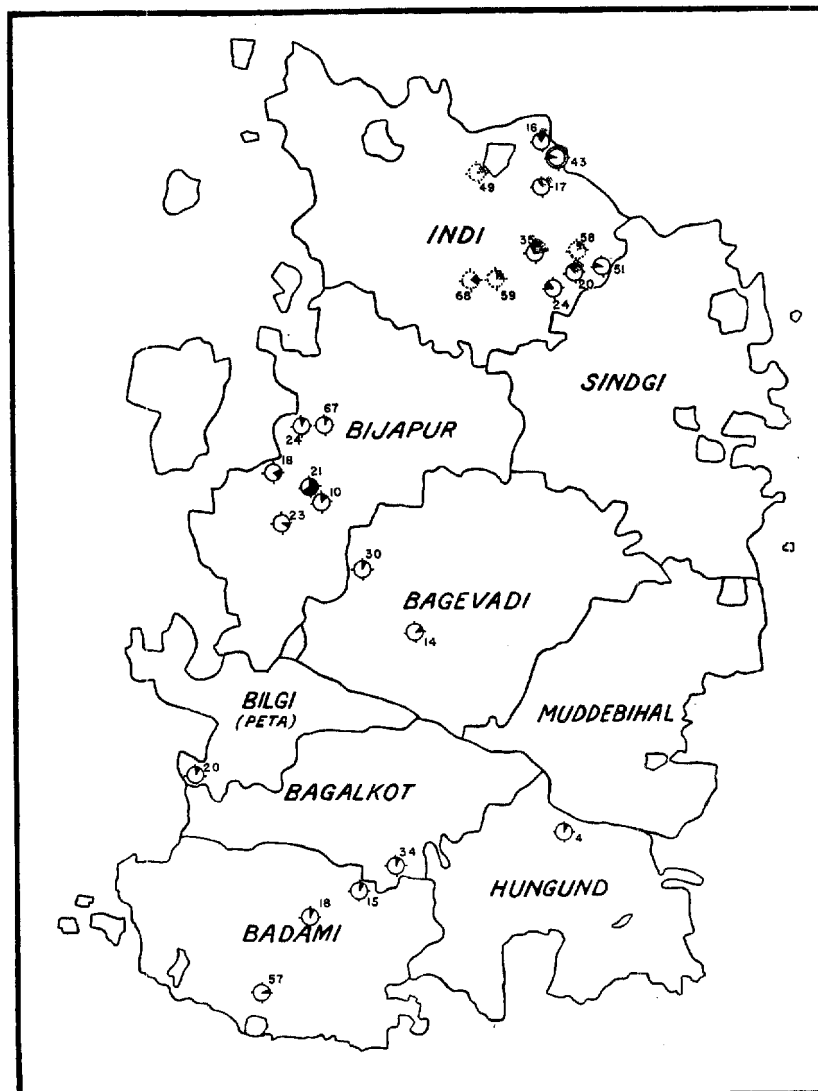
The plague records of the Sholapur District for 16 years clearly indicate that the infection, derived from the endemic centre in the Hyderabad State, mainly involved the talukas of Barsi and Sholapur. However, when the intensity of the infection increased, the talukas of Karmala and Madha became involved ; this was the case during 1945. The disease was absent from the district in 1931, 1937, 1938, and 1942, reappearing in 1932, 1939, and 1943, and increasing during 1933, 1934, 1940, 1944, and 1945. Thus there is a plague cycle of about five years' duration in this district.

2.11 *Bijapur District*

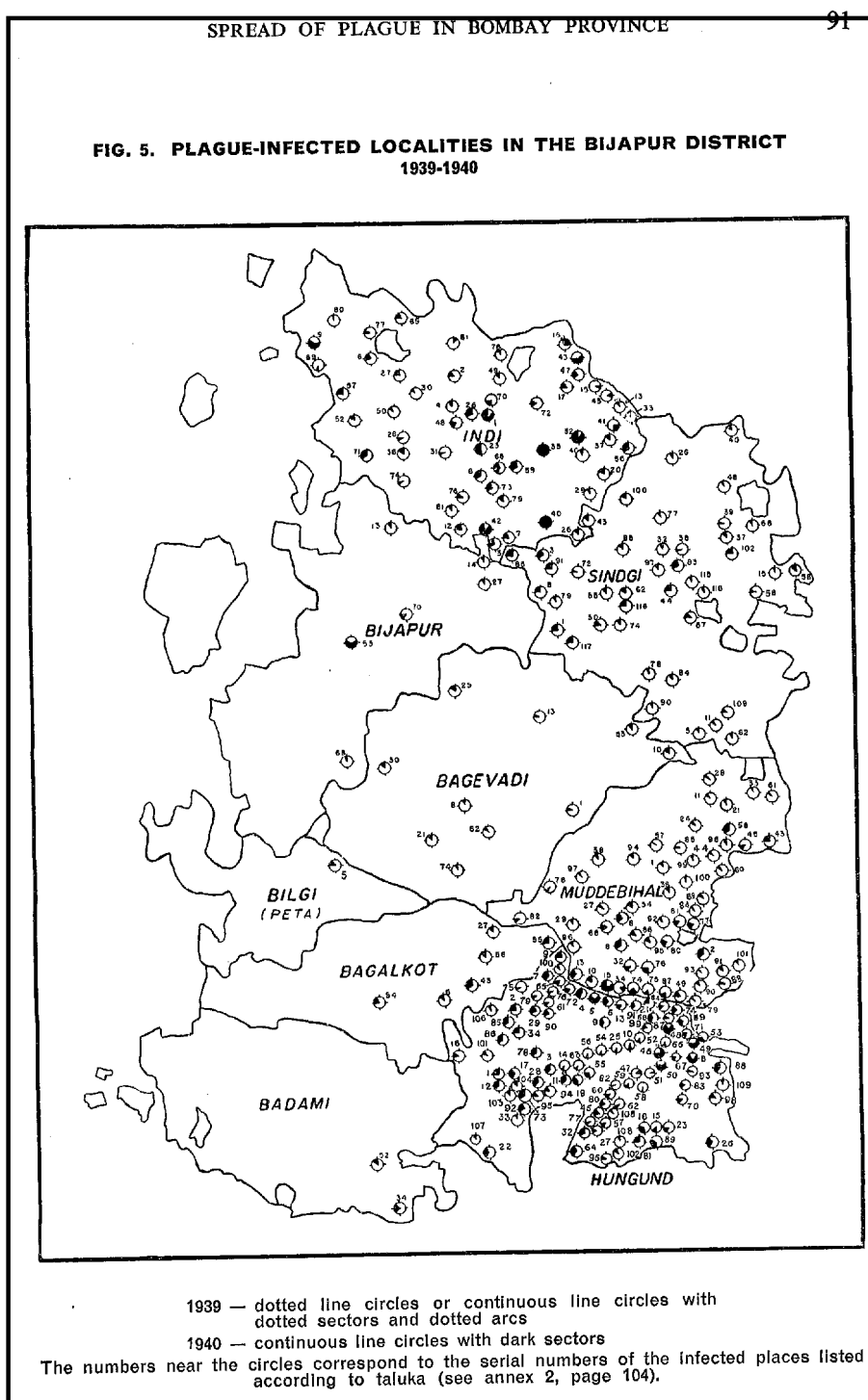
The plague manifestations in the Bijapur District are given below :

<i>Year</i>	<i>Localities affected</i>	<i>Description of outbreaks</i>
1930	29	All of the affected localities belonged to 5 southern talukas of the district, 20 being situated in those of Muddebihal and Bagalkot ; probably the infection was a partial extension of that existing at the time in the Dharwar District.

FIG. 4. PLAGUE-INFECTED LOCALITIES IN THE BIJAPUR DISTRICT
1935-1937



1935 — continuous line circles with dark sectors
1936 — dotted line circles or continuous line circles with
dotted sectors and dotted arcs
1937 — double line circles with dark sectors
The numbers near the circles correspond to the serial numbers of the infected places listed
according to taluka (see annex 2, page 104).



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1931	24	Incidence of the disease was reported from 6 southern talukas, 19 of the foci being in those of Bagalkot and Badami.
<i>Year</i>	<i>Localities affected</i>	<i>Description of outbreaks</i>
1932	132	The presence of plague in the southern talukas of Bagalkot and Badami, and the Bilgi Peta, during the early months of 1932 was probably due to a continuation of the infection present in 1931. However, later in the year a fresh invasion from the Belgaum District took place so that altogether 132 localities became affected during this year.
1933	381	In addition to the invasion from the Belgaum District, infection coming from the Hyderabad State also inundated the district and, as a result of the spread from the east and the south-west, numerous localities became involved.
1934	187	The infection, which had been present in 1933 in 44 localities of the southern talukas of Bagalkot, Badami and Hungund, and in the Bilgi Peta, flared up during 1934, involving 98 places out of the total affected in these 4 parts of the district.
1935	20	Plague declined considerably in 1935 (see fig. 4 and annex 2), only 20 localities scattered over most parts of the district being affected. Infection of the Indi Taluka appeared to have been derived from the Hyderabad State, while that of the western talukas seemed to have come from the Belgaum District.
1936	8	8 places of the Indi Taluka reported plague during the first half of the year.
1937-1938	1	Plague, still becoming manifest in 1 locality of the Indi Taluka in 1937, was absent from the whole district during the following year.
1939	5	The disease reappeared during this year (fig. 5 and annex 2), when 5 places belonging to the widely separated talukas of Indi and Hungund received infection from the neighbouring Hyderabad State.
1940	275	Out of the localities involved, 249 were in the talukas of Indi, Sindgi, Muddebihal, and Hungund, all bordering on the Hyderabad State.
1941	136	As shown in fig. 6 and annex 2, epidemics occurred in 136 places, 86 of which belonged to the above-mentioned 4 talukas. Thus there was a more marked westward progression of plague than in the previous year.
1942	2	Only 2 places in the Sindgi Taluka were affected, in continuation of the infection present there in 1941.
1943-1944	1	1 locality in the Bagewadi Taluka got infected in 1943, probably from the Belgaum District. No plague was recorded during the following year.
1945	2	Bijapur Town was reached by the infection coming from the district of Belgaum, and 1 locality in the Sindgi Taluka from the Hyderabad State.

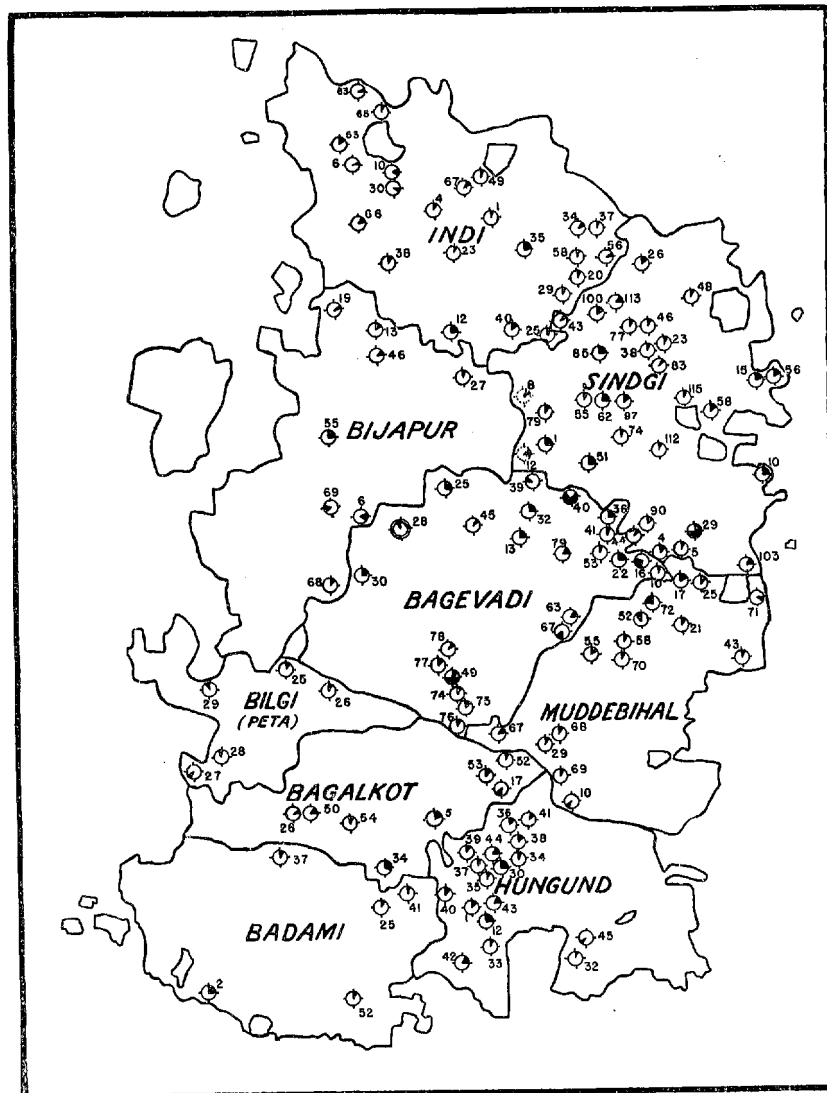
The course of plague incidence in the Bijapur District during the 16 years reveals that the district imports infection of threefold origin : first, from the Hyderabad State ; secondly, from the district of Belgaum ; and thirdly, from that of Dharwar. The invasion of the Bijapur District from the side of the Hyderabad State takes place either from the north side via the Osmanabad District of the Hyderabad State and the Sholapur District of the Bombay Province or directly from the east side through the Gulbarga District of the Hyderabad State. The western talukas of the

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FIG. 6. PLAGUE-INFECTED LOCALITIES IN THE BIJAPUR DISTRICT
1941-1943



- 1941 — continuous line circles with dark sectors
- 1942 — dotted line circles or continuous line circles with dotted sectors and dotted arcs
- 1943 — double line circles with dark sectors

The numbers near the circles correspond to the serial numbers of the infected places listed according to taluka (see annex 2, page 104).

Bijapur District receive infection from the Belgaum District and the southern ones from the Dharwar District when the endemic areas in these two districts attain a power of wide dissemination.

2.12 Ahmednagar District

The plague history of the Ahmednagar District may thus be summarized :

Year	Localities affected	Description of outbreaks
1930	1	1 locality in the Karjat Peta, situated near the Hyderabad State, became involved in the plague invasion affecting the northern and eastern talukas of the Sholapur District.
1931-1932	0	Plague was absent from the whole district.
1933	8	Involved were the talukas of Shrigonda and Parner, and the petas of Karjat and Jamkhed.
1934	9	The disease occurred in 9 localities of the talukas of Parner and Ahmednagar and of the Jamkhed Peta. The former 2 talukas probably received infection from the Poona District, the peta from the Hyderabad State.
1935	1	Only 1 place in the Jamkhed Peta was affected in 1935, probably in continuation of the infection present during the previous year.
1936-1942	0	Owing to the slight intensity of plague in the adjoining districts of Poona and Sholapur, Ahmednagar District remained free from plague during the period 1936-1942.
1943	1	The infection, imported from the Poona District, reappeared in the Ahmednagar City.
1944	2	In addition to the Ahmednagar City, 1 place in the taluka of Sangamner became affected.
1945	84	Due apparently to invasions from the districts of Sholapur and Poona, 84 localities became infected.

Sixteen years' records of plague in the district of Ahmednagar tend to show that infection was derived from the adjoining districts of Sholapur and Poona and the Hyderabad State. The plague incidence in the district depends thus upon the radiating power of the infection present in these three neighbouring territories.

An analysis of the plague epidemics occurring from 1930 through 1945 in the districts of the southern and central divisions of Bombay Province reveals that the disease radiates from endemic areas in the Western Ghats and in the hilly tracts of the Hyderabad State (fig. 7). It is possible to arrange the different regions of these divisions into three categories :

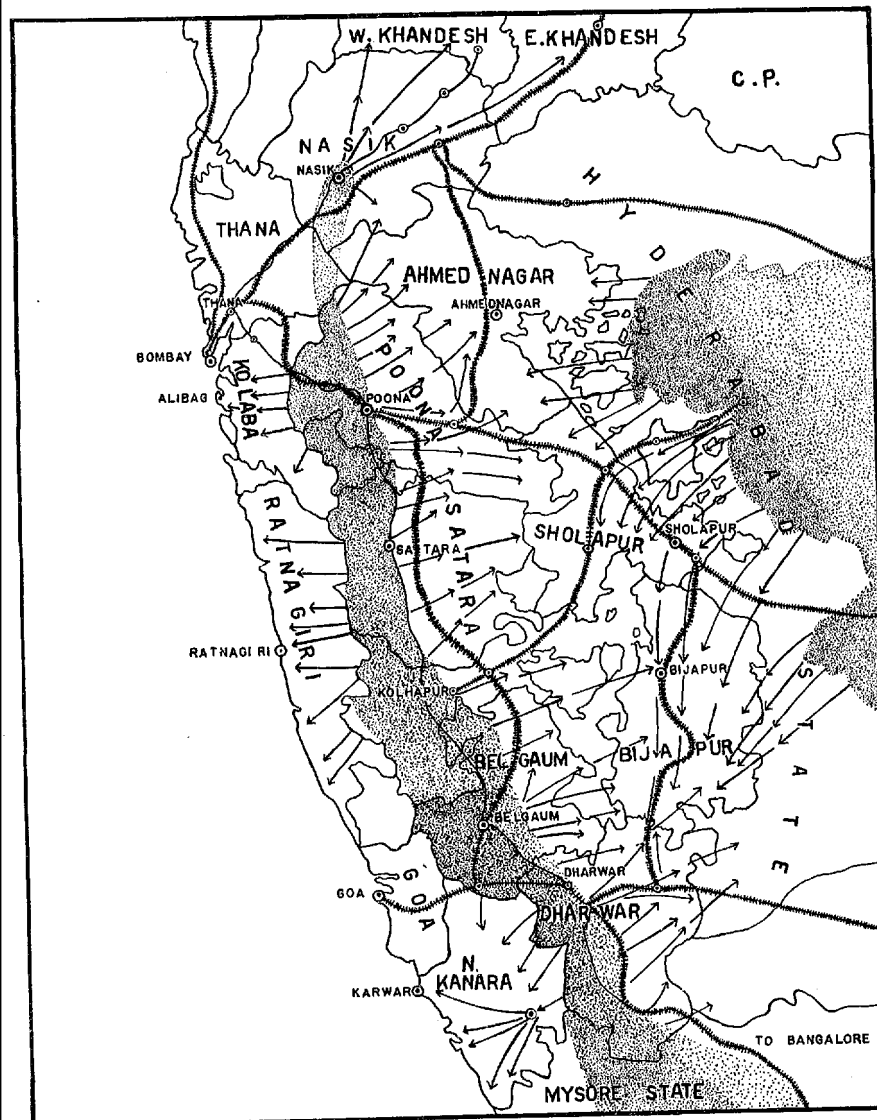
(1) Areas that have harboured the disease throughout these years, even though the plague intensity in them has varied to a great extent. They comprise the watersheds of the Western Ghats in the districts of Dharwar and Belgaum, and partly in those of Satara, Poona, and Nasik, from which the disease progresses largely eastwards. These can conveniently be con-

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FIG. 7. PLAGUE ENDEMIC CENTRES AND SPREAD OF PLAGUE IN CENTRAL AND SOUTHERN DIVISIONS OF BOMBAY PROVINCE
1930-1945



The intensity of shading indicates the potency of the endemic areas, and arrows indicate only the direction of radiation of plague but not the actual course of its progress.

sidered as forming an endemic centre, which is really a gently undulating plateau with moderate rainfall.

(2) The comparatively warm, flat areas showing a high degree of plague infection, whenever it is imported into them, such as the non-endemic districts of East- and West-Khandesh, Ahmednagar, Sholapur, and Bijapur, and the lowlands of Dharwar, Belgaum, Satara, Poona, and Nasik districts.

(3) Regions comprising mostly the eastern well-drained, sudden slopes and the top of the Western Ghats, like the districts of North Kanara, Ratnagiri, and Kolaba, which, owing to their location, have suffered very little from plague. Generally, a few of their commercial towns, trading with the endemic plague areas, have shown plague infection which appears to be mostly imported and does not gain a wide power of dissemination, possibly owing to a little grain traffic, on account of difficulties in communication in these districts, or, perhaps more likely, to their being excessively damp.

In the watersheds of the districts of Dharwar and Belgaum, plague has persisted ; but it has occasionally disappeared from those of Satara and Poona. The extent of eastward radiation of the disease from the endemic areas in the Western Ghats is not very wide, probably because there is not much grain traffic eastwards. Of the endemic zones in these four districts, the ones in the Dharwar and Belgaum districts are of a permanent nature, and those in the districts of Satara and Poona are semi-permanent. During the 16 years under review, plague has vanished completely once from the district of Satara and twice from that of Poona : apparently the watersheds in these two districts can act only as temporary but fairly lasting endemic plague areas. In the watersheds of the Nasik District, the conditions for maintenance of an endemic state are ill-developed, as is borne out by the disappearance of the disease from the district even when introduced in its watersheds, except once in 1945, when a plague invasion of the eastern parts of this district and a few places in the East- and West-Khandesh districts occurred. Thus the eastern watersheds of the Western Ghats lose the power of sustaining plague infection gradually as the distance northwards from the Belgaum District increases (fig. 7).

Plague infection in the districts of Sholapur and Bijapur appears to come from the endemic areas located in the hilly regions of the Hyderabad State (fig. 7). The former district was totally free from plague during 1937 and 1938, and the latter only in 1938. The disease first appeared in March 1939 in the taluka of Barsi, and by September 1939 it had moved southwards into that of Sholapur. If the infected villages of both these talukas are arranged according to the dates of commencement of human plague incidence, it becomes quite apparent that the disease moves from the Hyderabad State into the taluka of Barsi and then into that of Sholapur. Plague invaded a few adjoining villages of the Indi Taluka, Bijapur District, in December 1939 (fig. 5 and annex 2), after many places in the Sholapur

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Taluka had suffered from the disease. During 1940 it spread to many of the localities in the talukas of Indi, Sindgi, Muddebihal, and Hungund in the Bijapur District, which are adjacent to the Hyderabad State. The above-mentioned facts tend to show that plague radiates from the Hyderabad State to some of the talukas of Sholapur and Bijapur districts. The peak year in the Sholapur District appears to recur about every five years, with complete absence of plague for a year or two.

Bijapur District seems to get plague infection from the districts of Belgaum and Dharwar as well. The continuous infection from 1930 to 1937 was the result of a double-sided infection both from these districts and from the Hyderabad State and the Sholapur District. Similarly, the Ahmednagar District, though away from the ordinary range of radiation of endemic plague areas in the hilly tracts of the Hyderabad State and the Poona District, was affected when the infection had gained a great momentum on its march.

The progress of plague is subject to certain set rules. It is well known that the disease moves along the trade routes, usually through the agency of rat-fleas, or even rats, carried in the rat-favoured merchandise. Commercial centres get infected first, and then plague radiates from them into the neighbouring villages. It has been observed that in the non-endemic areas, such as are found in the Sholapur District, few localities get infected in one plague season, and then a very large number of them in the next one or two plague seasons. In the third or fourth plague season, only a few of them suffer, and then plague disappears for about a year or two. The sudden appearance of human plague in the second or third effective plague season in some places soon after the rainy season tends to show that dissemination of the disease can take place through rat-favoured merchandise even during the off-season. The mass movements of agricultural commodities begin after the harvesting season, and are in full swing before the monsoon starts ; then they are reduced considerably with the onset of rains by the middle of June. In this connexion, it is pointed out that weekly bazaars held in different places appear to play some part in the spread of plague. It would appear that some infected fleas are transported in the agricultural products and start a slow subterranean enzootic in certain favourable places before the infection flares up into a human epidemic in the plague season. The often continuous rains in July appear to increase the intensity of the epizootic, and many human cases occur in August, with continued increase up to the end of September. From the beginning of October to the middle of November, however, due to the reaction of adult fleas to a rise in temperature, there is a slight decline in human cases in some places of the non-endemic areas in Bombay Province. From December to February slight but steady increase in human plague occurs. The decline starts in March, and human cases mostly stop with the onset of the off season, the hot and dry summer months of April to June.

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3. Endemic Centres in the Indo-Pakistan Subcontinent

It has been shown above (page 94) that plague often radiates from an endemic centre. The necessary factors governing such a centre appear to be moderately damp and cool climatic conditions for a greater part of the year, which keep the soil, especially in the rat-burrows, moderately moist. These conditions permit continuous, good breeding of rat-fleas in burrows and their wandering away from them. Plague endemic centres are found at an elevation of 305-610 m (1,000-2,000 feet) in the temperate regions and 610-1,219 m (2,000-4,000 feet) in the tropical ones ³ having an annual rainfall of 20-40 inches, encountered mostly in the submontane regions of the Himalayas and in the gradual slopes of mountains, such as the watersheds or the broad valleys of the lower mountain ranges in central and peninsular India, respectively. The "cooler montane regions" were pointed out ⁹ as the endemic foci in Java and Madagascar. The disease does not occur in excessively damp areas, such as East Pakistan and Assam.² Taking the plague situation in the world, the endemic centres have been found in the low plateaux with moderate rainfall; but excessively dry areas like the Thar desert in the Indo-Pakistan Subcontinent have never shown endemicity of plague.

The complete absence of plague from extremely wet areas is due to the harmful effect of excessive moisture in combination with a soil rich in organic material on the breeding of rat-fleas, as has recently been shown by me.¹⁰ This is further borne out by the fact that, in the city of Bombay, the plague season used to correspond to the off-season of Poona ² and most other places in Bombay Province. In Bombay City the decline of plague used to start from June, and the plague mortality was extremely low from July to January,⁹ when an excessive wetness of the soil results from heavy rainfall in the months of June to September. When the soil dried owing to lack of rainfall from October to May, plague used to flare up in the months of March, April, and May.

The present pandemic wave of plague on its march into the Indo-Pakistan Subcontinent has left some stagnant pools in the form of endemic centres which remain potent sources of danger for a flare-up of plague in the surrounding areas. The extent of the areas invaded by plague depends upon the intensity with which it spreads and the momentum the disease gains during its march: on reaching the warmer lowlands and plains, it loses its vigour and finally disappears. The extent of the infected areas increases or decreases very gradually, showing a secular tendency, and the duration of the cycle varies in the different regions.

Plague, not being a stationary disease, moves from place to place. Even in an endemic centre it is never confined to any definite locality, though it persists in certain adjacent areas having more or less identical climatic conditions. Consequently, no particular locality can be designated

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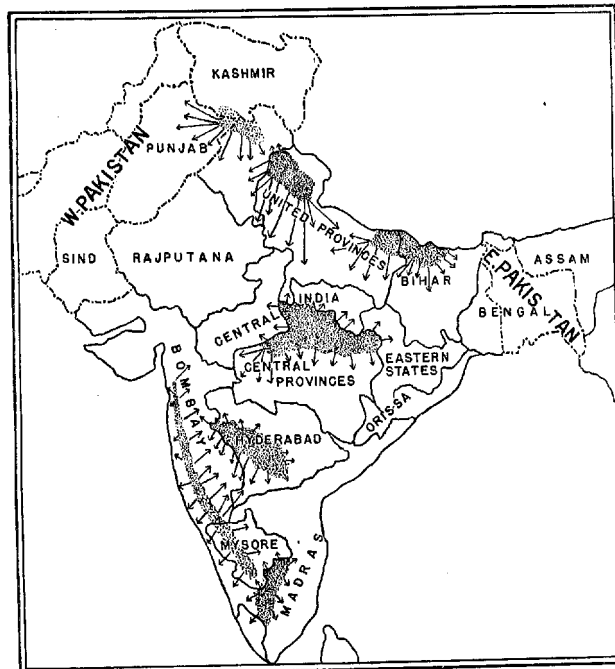
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as an endemic focus in the literal sense ; but it is possible to define large areas in which plague always remains and moves about, Such areas have been defined (see page 94) in Dharwar, Belgaum, Satara, and Poona districts ; these comprise the eastern watersheds of the Western Ghats located in these districts, which even extend into the Mysore State.

The criteria adopted for determining the endemic plague centres are two in number :

(1) Continuous persistence of plague in them for several years, especially during a period of decline. Ever since 1930 the disease has markedly decreased in the Indo-Pakistan Subcontinent.⁹ However, the state of plague infection during 1930 to 1945 should enable such endemic centres to be defined, as plague persists in its natural haunts for a much longer time, sometimes even with a lower incidence than in the non-endemic areas.

FIG. 8. PLAGUE ENDEMIC CENTRES OF THE INDO-PAKISTAN SUBCONTINENT



Arrows indicate only the direction of radiation of plague but not the actual course of its progress.

(2) Duration of the plague-season for six months or more in a year. This is clearly borne out by the data given by White.¹⁶ Endemic centres are situated, as a rule, only in administrative areas showing a heavier mortality for six or more months than the average monthly mortality

based on 20 years' plague data of the Indo-Pakistan Subcontinent, the exceptions being East and West Punjab, where the endemic plague centre displays less potency, and Bihar, owing to its one-sided location.

From the past records of plague incidence in the Indo-Pakistan Subcontinent, as given in the annual reports of the Public Health Commissioner with the Government of India for 1930-1945^{5, 6} and as compiled by others,^{9, 16} it is, however, possible to delimit the various endemic centres. A careful and detailed study of these records has enabled me to surmise the boundaries of seven endemic centres in this subcontinent (fig. 8) with a fair degree of accuracy.

There appear to be three endemic plague centres situated near the foot of the Himalayas. The first one includes the submontane plains of the Jammu State and the districts of Sialkot, Gurdaspur, and Hoshiarpur, where plague has been quiescent since 1937. This endemic centre had radiated infection mostly to the neighbouring districts lying to the south, south-west, and west. The second endemic centre⁸ comprises the submontane districts of Dera Dun, Saharanpur, Muzaffarnagar, Bijnor, Moradabad, Naini Tal, and Bareilly. It has been sending plague infection to the neighbouring districts of the East Punjab and most of the western districts of the United Provinces. This centre has been responsible for a heavy mortality even up to the present time and seems to be connected with the first one through the Ambala District. Perhaps these two constitute one common endemic centre, the western part of which is inactive for the time being. The third one includes the submontane districts of Basti and Gorakhpur in the United Provinces and those of Champaran, Muzaffarpur, and Darbhanga in Bihar. This endemic centre has been mostly inundating the eastern districts of the United Provinces and districts of Bihar lying north of the river Ganges. All three areas may possibly be parts of a big sub-Himalayan endemic centre, but there have been occasions when they have operated independently of one another.

In the central Indian plateau there is one endemic centre (fig. 8), comprising the watersheds of the Vindhya, Bhanrer, and Maikal ranges and the Mahadeo hills. It includes the hilly districts of Saugor, Jubbulpore, Hoshangabad, Betul, Chindwara, and Mandla. Plague emerges from there into the neighbouring parts; but the area invaded by the disease during the period of 1930 to 1945 was not wide and the mortality percentage has been very low in recent years.

In southern India, there appear to be three endemic plague centres (fig. 8). The first one includes the eastern watersheds of the Western Ghats in the districts of Belgaum, Dharwar, Poona, and Satara, and the Mysore State.^h The southern greater part of this endemic centre has been very

⁸ An endemic centre existed in the districts of Gharwal and Kumaon even before the present pandemic, and it was responsible for a series of plague outbreaks during 1849-1877.

^h For detailed plague records of the Mysore State, see also Karve & Sundararajan.⁷

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active ever since plague reached it in 1898. The second comprises the watersheds of the Shevaroy, Nilgiri, Palni, and Cardamom hills located in the districts of Salem, Coimbatore, Nilgiri, and Madura. The first is probably a continuation of the second. The third endemic centre is situated in the Hyderabad State and includes the watersheds of the Balaghat range and the adjoining hills in the districts of Bhir, Osmanabad, Bidar, Gulbarga, Medak, Atrai-i-Balda, and Mahbubnagar. These three endemic centres have been very active lately.

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ACKNOWLEDGEMENTS

It is indeed a pleasant duty to express my gratitude to Major-General Sir Sahib Singh Sokhey, formerly Director of the Haffkine Institute, Parel, Bombay, for affording me many facilities for the pursuit of these investigations and for his encouragement and advice. Dr. K. A. Gandhi, formerly Director of Public Health to the Government of Bombay, was kind enough to supply me with the plague records of Bombay Province and with different kinds of maps. I am greatly indebted to him for this and other help rendered in the prosecution of this work.

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Annex 1

**PLAGUE-INFECTED
LOCALITIES OF THE PARTIALLY ENDEMIC
DISTRICT OF DHARWAR, 1935-1940 ***

No.	Name of locality	No.	Name of locality	No.	Name of locality
<i>Dharwar Taluka (endemic)</i>					
3	Shivhalli	26	Amminbhavi	48	Chandanmatti
8	Satur	31	Mugud	52	Yadwad
19	Devar Hubli	40	Vanhalli	54	Maradgi
21	Hebbli	45	Kardigud	57	Somapur
25	Navalur	47	Talwai	74	Dharwar Town

* Arranged by taluka.

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No.	Name of locality	No.	Name of locality	No.	Name of locality
<i>Kalghatgi Taluka (endemic)</i>					
2	Dyamankond	23	Kudalgi	41	Yelvadhal
4	Kalghatgi Town	24	Dastikop	42	Arlihond
6	Machapur	26	Nelliharvi	43	Bagadgeri
7	Bendigeri	27	Bisaralli	44	Shivnapur
9	Tumrikop	29	Jinnur	45	Belvantar
10	Mukkal	31	Hire Honnihalli	46	Hindasgeri
11	Rangapur	38	Tabkad Honnihalli	47	Birvalli
13	Bommigatti	39	Tavarger	48	Solargop
16	Guddad Hulikatti	40	Sangmeshwar	49	Aladkatti
<i>Bankapur Taluka (endemic)</i>					
3	Hireharkuni	23	Tarlaghat	55	Chick Bendigeri
7	Hirebudihal	28	Hulgur	58	Hurlikuppi
8	Kyalkond	29	Mattigatti	60	Challal
9	Artal	31	Halebankapur	64	Attigeri
10	Karadgi	34	Ingalgi	66	Bannur
12	Tadas	35	Belvalkop	68	Ganjigatti
13	Shilwant Somapur	38	Advisomapur	69	Bankapur Town
14	Dhundashi	39	Malali	73	Fakir Nandihalli
17	Bulpankop	44	Ramankop	74	Kalkatti
18	Kundur	45	Guranhalli	75	Hanmanhalli
20	Guddad Channapur	46	Tirth	76	Hidgundi
21	Shiggaon	47	Hire Bendigeri	77	Panigatti
22	Jalikatti				
<i>Hangal Taluka (endemic)</i>					
4	Bomanhalli	20	Alur	38	Kusnur
7	Hangal Town	25	Dolleshwar	40	Havangi
9	Hanamsagar	27	Hirur	60	Hire Kanagi
12	Niralgi Adur	34	Balambid	61	Balur
19	Kallapur				
<i>Kod Taluka (endemic)</i>					
4	Kod	27	Devagihalli	37	Hadigond
7	Chickkerur	31	Havasbhavi	54	Ablur
13	Ingalgendi Hirekerur	34	Jogihalli Kuppelur	55	Sudambi
<i>Ranebennur Taluka (non-endemic)</i>					
28	Motebennur	74	Ranebennur Town	75	Kooli
59	Nukapur				
<i>Karajgi Taluka (non-endemic)</i>					
1	Kadkol	7	Agadi	15	Guttal
2	Devgeri	10	Yalgach	17	Devi Hosur
3	Nilogal	11	Haveri	30	Negluri

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No.	Name of locality	No.	Name of locality	No.	Name of locality
36	Aladkatti	53	Malapur	90	Yattinhalli
38	Karajgi Town	62	Kabbur	91	Karimattihalli
39	Hosritti	65	Hommraddi	92	Kankapur
42	Kanavalli	73	Kalsur	93	Sullihalli
47	Katenhalli	81	Kurubgond	94	B. Kodihalli
50	Melmari	89	Tallihalli		
<i>Hubli Taluka (non-endemic)</i>					
1	Hallihal	23	Rottigwad	43	Nagshettikop
3	Byahatti	25	Konkankurhatti	46	Koliwad
4	Mantur	26	Sulla	49	Kardikop
5	Gopankop	29	Umachgi	50	Budarsinghi
8	Shirguppi	32	Varur	51	B. Arlikatti
10	Kotgondhanshi	33	Hebsur	53	Hubli Town
11	Agadi	34	Ingalhalli	54	Chabbi
15	Hirenarti	36	Kiresur	55	Ramapur
17	Adarganchi	38	Gokul	56	Virapur
18	Pale	39	Nagarhalli	57	Belgali
20	Keshwapur	40	Bhandiwad	58	Kardikeri
22	Kusugal	42	Yerinarayanpur		
<i>Navalgund Taluka (non-endemic)</i>					
6	Annigeri	26	Bassapur	46	Manakwad
8	Siswinhalli	27	Hallikeri	52	Navalgund Town
13	Bhadrapur	38	Arekurhatti	53	Nalvadi
14	Morale	43	Nagarhalli	54	Saidapur
24	Tirlapur				
<i>Gadag Taluka (non-endemic)</i>					
2	Hombal	18	Malsamudra	38	Hulkoti
7	Antur	28	Hosur	41	Papanashi
11	Chikkop	35	Binkadkatti	45	Advisomapur
14	Kotmuchagi	37	Niralgi	49	Gadag Town
<i>Mundargi Peta (non-endemic)</i>					
2	Jantli	9	Shirur	14	Halligudi
4	Mundargi	13	Hallikeri	15	Byalwadgi
<i>Ron Taluka (non-endemic)</i>					
3	Naregal	14	Hanmanhal	34	Kotabal
4	Belvanki	15	Abbigeri	35	Hadgali S. Dombal
6	Ron Town	19	Gajendragad	37	Jakkali
12	Savadi	21	Mallapur	52	Hungundi
13	Arahunshi	27	Sudi		

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Annex 2

PLAGUE-INFECTED LOCALITIES OF
THE NON-ENDEMIC DISTRICT OF BIJAPUR, 1935-1943 *

No.	Name of locality	No.	Name of locality	No.	Name of locality
<i>Hungund Taluka</i>					
1	Amingarh	40	Huvinhalli	75	Kadapati
2	Ganjihal	41	Khajigali	76	Kamdatt
3	Hungund Town	42	Kelur	77	Tondihal
4	Dhannur	43	Hulginal	78	Timmapur
5	Hullalli	44	Khairvadgi	79	Varagodadinni
6	Kopp S. Marol	45	Herur	80	Chinapur S. Tumb.
7	Sangam	46	Hemvadgi	81	Hire Otgeri
8	Kardi	47	Nidasanur	82	Hire Hunkunti
9	Marol	48	Manmathnal	83	Chick Adapur
10	Chint Kamaldinni	49	Pochhapur	84	Indvar
11	Amravati	50	Budihal S. Kardi	85	Hire Malgar
12	Sulibhavi	51	Tarival	86	Chittargi
13	Havargi	52	Jayl Kamaldani	87	Kesarpeni
14	Ramvadgi	53	Chinnapur S. Kardi	88	Kambalihal
15	Hire Shingangutti	54	Revadinal	89	Chick Otgeri
16	Kamatgi	55	Ghattignur	90	Bislalkop
17	Rakkasgi	56	Bekanialdinni	91	Kavjagnur
18	Chick Shingangutti	57	Ingalgi	92	Nagnur
19	Binjvadgi	58	Jambaldinni	93	Benkandoni
21	Anapkatti	59	Chatnihal	94	Chick Badvadgi
22	Gudur S. Chikknal	60	Kesarbhavi	95	Virapur
23	Krishnapur	61	Iddalgi	96	Chick Kodagali
25	Kadival	62	Tumb	97	Bislaldinni
26	Kandgali	63	Hagedal	98	Nandvadgi
27	Gorubal	64	Balkundi	99	Lolsar
28	Hire Badvadgi	65	Adihal	100	Chaud Kamaldinni
29	Belgall	66	Palthi	101	Hire Magi
30	Gangur	67	Konnur	102	Hire Kadgali
32	Ilkall Town	68	Kamaldinni	103	Honnerhalli
33	Tallikeri	69	Amravadgi	104	Bevinmatti
34	Kirsur	70	Hire Adapur	105	Gopsam
35	Madapur	71	Dasbal	106	Amtikopp
36	Hannur	72	Yammihatti	107	Chiknal
37	Chick Magi	73	Bannihatti	108	Gudur S. Balkundi
38	Medinapur	74	Islampur	109	Harnapur
39	Budihal (Inam)				
<i>Muddebihal Taluka</i>					
1	Ingalgeri	8	Kolur	13	Tangadgi
2	Naltwad	10	Amargol	15	Garsangi
6	Muddebihal Town	11	Bolwad	17	Tumbagi

* Arranged by taluka.

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No.	Name of locality	No.	Name of locality
21	Bommanhalli	57	Lingadhalli
24	Minjgi	58	Wanhalli
25	Hoshalli	60	Nagur
27	Bidarkundi	61	Belur
28	Fatepur M. Talikot	67	Wadwadgi
29	Yarzari	68	Hadalgeri
32	Yargal	69	Devoor
33	Karganur	70	Nadhalli
34	Hunkunti	71	Shelligi
36	Jamaldinni	72	Hirur
38	Dhavalgi	74	Bhangargund
43	Salvadgi	75	Rakkasgi
44	Kaldevanhalli	76	Alur
45	Masknal	77	Jainapur
49	Gudnal	78	Hullur
52	Tamadhaddi	79	Ingalgi
54	Kuntoji	80	Arasnal
55	Hallur	81	Mavinbhavi
56	Kop	82	Masuti
<i>Sindgi Taluka</i>			
1	Hippargi	43	Surgihalli
3	Rugi	44	Chick Sindgi
4	Ambalnur	46	Kalhalli
5	Kesarhatti	48	Asangihal
8	Malsawalgi	51	Jyalwad
10	Honahalli	55	Otihal
11	Binjalbhavi	56	Goravgundi
12	Padganur	57	Byakod
15	Nagavi Kd.	58	Yankenchi
23	Benkootgi	62	Budihal P. Hippargi
26	Almel	66	Gabsavalgi
29	Kalkeri	72	Chitargi
30	Bomanjogi	74	Kokotnur
32	Ganthar	77	Hikkangutti
37	Abheri	78	Korwar
38	Ranpur P.A.	79	Nivalkhodi
39	Mangrul	82	Jalapur
40	Devangoon	83	Sindgi Town
<i>Indi Taluka</i>			
1	Indi	13	Roodgi
2	Bhatgunki	15	Nagarhalli
3	Shirkaulhalli	16	Agarkhed
4	Anjotgi	17	Hirebevnur
6	Bardol	20	Shirshyad
7	Kenginal	23	Hanji
8	Tadwalga	24	Hirenasbi
9	Chandehan	25	Bhantnal
10	Jhalki	26	Chick Bevnoor
12	Atharga	27	Jewoor
84	Somnal	85	Kuchbal
86	Sarur	87	Takkalki
88	Sultanpur	89	Donkmadu
90	Ghalpuji	91	Gagnapur
92	Hiremural	93	Lotgeri
94	Balvat	95	Narebenchi
96	Nagral	97	Basarkod
98	Hadginal	99	Bavur
100	Hagargund	101	Bachihal
84	Handignur	85	Chandkavthe
86	Ganganhalli	90	Kondguli
91	Kadlewad P. Chandkavathe	97	Bandal
100	Balganoor	102	Yargal Bk.
103	Niralgi	109	Ranpur P. Tabkot
112	Shakhapur	113	Nagarhalli
115	Manapur	116	Kannolli
117	Mannur	118	Antargangi
28	Halgunki	29	Sangoji
30	Balloli	31	Bablad
32	Satalgaon P. Indi	33	Miragi
34	Lalsangi	35	Salotgi
37	Golsar	38	Horti

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No.	Name of locality	No.	Name of locality	No.	Name of locality
40	Tambe	53	Godihal	70	Mayginhalli
41	Shivapur Kd.	56	Arjungi B.K.	71	Savalsang
42	Benkanhalli	57	Nimbargi	72	Ingalgi
43	Mannur	58	Nad Kd.	73	Ganvalga
45	Khedgi	59	Rugi	74	Deginal
46	Nad B.K.	61	Halsangi	76	Lingadhalli
47	Bhayar	63	Umrani	77	Kanchenal
48	Chandyal	65	Taddewadi	78	Loni Kd.
49	Ahirsang	66	Hadalsang	79	Tenihalli
50	Nandargi	67	Budihal	80	Havival
51	Marsanhalli	68	Bolegan	81	Rajnal
52	Satalgaon P. Bardol	69	Kohkangaon		
<i>Bijapur Taluka</i>					
6	Honganhalli	21	Kanmuchnal	55	Bijapur Town
10	Sarwad	23	Bableshtar	67	Navaraspur
13	Tidgundi	24	Torvi	68	Karjol
14	Honahalli	27	Jambagi	69	Dadenhatti
18	Danyal	46	Kanal	70	Kaulgi
19	Komnur				
<i>Bagewadi Taluka</i>					
1	Salwadgi	30	Mulwad	62	Hangargi
8	Muttagi	32	Rabinal	63	Byakod
10	Sasnur	36	Yelwar	67	Jaywadgi
13	Ingleshwar	39	Markkabinhalli	74	Benal
14	Telgi	40	Bhairwadgi	75	Gonal
16	Chabnur	41	Kadkol	76	Araldinni
21	Chickasangi	44	Sindigeri	77	Guddadinni
22	Somnal	45	Deginal	78	Hunshyal P. Chimalgi
25	Ukkali	49	Vandal	79	Budihal
28	Mangoli	53	Nandihal P. Hippargi		
<i>Bilgi Peta</i>					
5	Korti	26	Takkalki	28	Arkeri
20	Kundargi	27	Algundi	29	Bisnal
25	Dhavaleshwar				
<i>Bagalkot Taluka</i>					
5	Hallur	34	Sirur	53	Chitkinkop
17	Devlapur S. Mankeri	43	Bivoor	54	Bagalkot Town
26	Murnal	50	Virapur	55	Handargal
27	Nainglee	52	Mankani	56	Badnyakdinni
<i>Badami Taluka</i>					
2	Bisnur	25	Kotikal	41	Guledgudd Town
15	Kalwadi	34	Belur	52	Nagral S. Patadkal
18	Halkurki	37	Kagolgombe	57	Nielgund

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SUMMARY

In Bombay Province, wild rodents do not play any part in the perpetuation and transmission of plague ; only domestic rats are involved. During the off-season the infection runs the course of a slow subterranean enzootic in some suitable places. The end of the hot and dry off-season is marked by the onset of the rainy season, which operates in two ways : first, it increases the rat population indoors ; secondly, it lowers the temperature and raises the humidity, which leads to an increase of the flea population and permits the fleas to leave the rat burrows and to attack human beings.

The idea that plague is more a rural than an urban problem appears to be fallacious. The disease may not break out severely in the commercial towns ; but still they play an important role in dispersing plague to villages, where it flares up owing to the higher susceptibility of their rat populations.

There are two types of plague epizootics. In warm tablelands and plains, the infection is often severe, leading to a very heavy mortality among rats, which results in the disappearance of the disease within a short time. In the cooler regions comprising the watersheds of the Western Ghats, plague infection is slow-spreading and persists for a long time owing to lower rat mortality ; these areas, which have moderately moist and cool climatic conditions throughout most of the year, are considered to constitute an endemic plague centre.

By plotting plague-infected places during the period of 1930 to 1945 on skeleton maps of all the districts of the southern and central divisions of Bombay Province, an attempt has been made to study the progress of the disease. The analysis of 16 years' plague epidemics in these two divisions indicates that the infection emerges from the endemic centre located

RÉSUMÉ

Dans la province de Bombay, les rongeurs sauvages ne jouent aucun rôle dans la persistance et la transmission de la peste : seuls, les rats domestiques sont en cause. Pendant la période d'accalmie, l'infection revêt la forme d'une enzootie lente et sous-jacente dans certains endroits appropriés. La fin de cette période, chaude et sèche, est marquée par l'apparition de la saison des pluies, dont l'influence se fait sentir de deux manières : en premier lieu, la population murine vivant à l'intérieur des habitations s'accroît ; en second lieu, la température diminue et le degré hygrométrique s'élève, ce qui provoque un accroissement des pulicidés et permet aux puces de quitter les trous de rats et de s'attaquer aux êtres humains.

L'idée selon laquelle la peste constituerait un problème rural plutôt qu'urbain paraît erronée. La maladie peut ne pas se manifester de façon grave dans les villes commerciales, mais celles-ci jouent cependant un rôle important en propageant la peste aux villages, où l'infection apparaît soudain avec brutalité en raison de la réceptivité de leur population murine.

Il existe deux types d'épizooties pesteuses. Dans les régions chaudes de plateaux et de plaines, l'infection est souvent grave ; elle provoque une mortalité très élevée parmi les rats et, en conséquence, la maladie disparaît assez rapidement. Dans les régions plus froides qui comprennent les bassins des rivières des Ghâtes occidentales, l'infection pesteuse se répand lentement et persiste pendant longtemps, en raison d'une plus faible mortalité de la population murine. Ces régions, où l'humidité est modérée et la température assez fraîche pendant la plus grande partie de l'année, sont considérées comme constituant un foyer endémique de peste.

On s'est efforcé d'étudier la marche de la maladie en marquant sur des cartes synoptiques, pour tous les districts de la division méridionale et de la division centrale de la Province de Bombay, les localités infectées par la peste au cours de la période 1930-1945. L'analyse des épidémies de peste survenues au cours de ces 16 années dans ces deux divisions montre

in the Western Ghats and that in the hills of the Hyderabad State. The district of Sholapur always imports plague from the Hyderabad State ; all the other districts, from the endemic centre situated in the Western Ghats. Bijapur and Ahmednagar districts, however, receive infection from both these endemic centres. The districts of North Kanara, Ratnagiri, and Kolaba suffer little from plague on account of their location on the eastern sudden slopes and top of the Western Ghats. The power of dissemination of plague from towns in these three districts is very slight, probably owing to less grain traffic or to the excessive dampness of the area.

In the Indo-Pakistan Subcontinent, seven endemic plague centres could be delimited. Three of them are located in the sub-montane plains of the Himalayas. Of the others, three are found in watersheds of the mountain ranges of southern India and one in those of central India.

que l'infection a sa source dans le foyer endémique des Ghâtes occidentales et dans celui qui est situé dans les collines de l'Etat de Hyderabad. Dans le district de Sholapur, la peste est toujours importée de l'Etat de Hyderabad ; dans tous les autres districts, elle l'est du foyer endémique des Ghâtes occidentales. Toutefois, dans les districts de Bijapur et d'A Ahmednagar, l'infection peut provenir des deux foyers endémiques. Les districts de Kanara Nord, de Ratnagiri et de Kolaba sont peu touchés par la peste, étant donné leur situation sur les pentes orientales abruptes et au sommet des Ghâtes occidentales. La maladie ne s'y propage que fort peu depuis les villes, probablement en raison d'un trafic de céréales plus réduit ou de l'humidité considérable que l'on constate dans cette région.

Dans le sous-continent indo-pakistanaï, sept foyers endémiques de peste ont pu être délimités. Trois d'entre eux sont situés dans les plaines qui se trouvent au pied de l'Himalaya ; trois autres foyers sont situés dans les bassins des secteurs montagneux de l'Inde méridionale, et un dans ceux de l'Inde centrale.

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